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Peripheral Intravenous Cannula Fracture: Increasing Incidence And Management

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Abstract
Background*: Peripheral Intravenous Cannulation is a routine invasive procedure in clinical practice with various associated complications including cannula fracture.*
Objective*: To evaluate the incidence of peripheral IV cannula fracture and its management.*
Materials and Methods*: This was a prospective cross-sectional study conducted at the University of Port Harcourt Teaching Hospital between April 1, 2019, and December 31, 2021. A data co9llection tool designed specifically for the study was used to obtain information on the size of the cannula, cadre of doctor that inserted the cannula, the brand of the cannula, history of reinsertion of the introducer needle during cannulation, duration of the intravenous cannulation, time of presentation and successful retrieval rate.*
Results*: There were 15 cases of broken peripheral IV cannulae. The patients were aged 25-44years, consisting of 1 (6.67%) and 14 females (93.33%). All the cannulae were 16G (gray) and were inserted mostly preoperatively for caesarean section, 7 (46.67%) of them were inserted by consultants, 4 (26.67%) by Senior Registrars and 4 (26.67%) by Registrars. All the 16G cannulae were made by the same manufacturer. The introducer needle was reinserted in 4 (26.67%) cases. On the average, the cannulae lasted between 3-5days intravenously, 10 (66.67%) of the cases presented within 24hours while 5 (33.33%) presented after 24hoours. Most 12 (80%) of the fractured cannulae segments were successfully retrieved while 3 (20%) had migrated. These peripheral cannula fractures were more prevalent in the first year of the study, where 12 cases were reported. The hospital management was notified of the increase in the rate of peripheral cannula fracture and the use of the brand of peripheral cannula was discontinued.*
Conclusion: *Though technical error during insertion is an issue, the quality of the cannula in these cases appeared to contribute to the increased rate of cannula fracture. Hence, timely presentation is key to successful retrieval.*
Keywords*: Cannula; Intravenous; Peripheral; Fracture; Retrieval; Port Harcourt.*

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I. Introduction

Aside from vital sign measurement, intravenous cannula insertion is one of the first procedures carried out on patients in both the emergency and in-patient wards.[1] Since its discovery by Christopher Wren in the 16th century, the procedure has become one of the most widely used intravascular procedures.[1,2] A peripheral intravenous cannula (PIC) is inserted into the peripheral vein for the purpose of blood sample collection, drug administration, and fluid administration.[3] Generally, the important components of a PIC includes the hub, flashback chamber, pair of wings, catheter, metal trocar and trocar grip.[3] Common medical devices such as cannulas, catheters, needles, and other metallic tools may be trapped distally along the blood circulation, resulting in bleeding, infections, and thrombosis.[4]

Although PIC fracture is rare and sometimes not reported or even under reported, it could result in severe complications.[5] Thrombophlebitis, haematoma, extravascular infiltration, septicaemia, embolism, nerve injuries, tendon, and muscle damages, have all been associated with the PIC fracture.[5,6] Proximal embolization of the fractured segments may cause secondary complications like dysrhythmia and myocardial infarction .[5] However, distal embolization has been reported to occur, which is a condition where the fractured cannula segments migrate from the site of the fracture and embolizes to another location.[7] Furthermore, mortalities arising from PIC fracture complications was reported by Freiberg et al and Bloom et al.[8,9]

The diagnosis and detection of PIC fractured segments is often challenging. Early diagnosis and detection are however made easier with the aid of radiological techniques such as computed tomography (CT), plain X-ray, C-arm fluoroscopy and even ultrasonography.[6,7,10-12] Surgical interventions such as longitudinal and transverse techniques are therefore employed for immediate retrieval.[5] There is paucity of data on the incidence

and management of PIC fracture in our environment. Therefore, the study sought to investigate the increasing incidence of peripheral IV cannula fractures in our environment and their management.

II. Materials And Methods

Study Area

This study was conducted at the obstetrics and gynaecology and cardiothoracic and vascular surgery unit of the University of Port Harcourt Teaching Hospital (UPTH). The University of Port Harcourt Teaching Hospital is a 988-bed hospital in Alakahia, in Obio-Akpor Local Government Area of Rivers state. It is a tertiary hospital that serves as a referral centre for all levels of healthcare in Rivers state and other neighbouring states including Bayelsa, Imo and Abia. The department of obstetrics and gynaecology has 175 beds, making up 17.7% of the total bed spaces. Patients who had peripheral intravenous cannula fracture were evaluated by cardiothoracic and vascular surgery unit at the in-patients and the accident and emergency wards and recruited for the study.

Methods

This is a prospective cross-sectional study of 15 patients with peripheral intravenous cannula fracture clinical who were managed at the University of Port Harcourt Teaching Hospital between April 1, 2019, and December 31, 2021. After obtaining informed consent, the patients' information was collected using a data collection tool and data was entered into a Microsoft excel spreadsheet in sequential order. Data obtained included the size of the cannula, cadre of doctor that inserted the cannula, the brand of the cannula, history of reinsertion of the introducer needle during cannulation, duration of the intravenous cannulation, time of presentation and successful retrieval rate. Each patient was given a unique identifier number to ensure anonymity and ease of identification. The data collection tool was checked for accuracy and completeness.

Retrieval Procedure

Following notification of PIC fracture by the managing team, the cardiothoracic and vascular surgery unit evaluated the patient. Thereafter, a tourniquet was applied proximal to site of cannula fracture, to limit the chances of migration. Within a 30-minute period, the fractured segments for most of the reported cases were confirmed by palpitation, though some required the use of Duplex scan. However, when the fractured segment was not readily palpable, marking of the site was done using a duplex scan and the patient was taken to a procedure room. Under aseptic conditions and local anaesthesia, a skin incision was made at the site and venotomy was carried out. The fractured segment was retrieved, with the venotomy repaired or ligated depending on the size of the vein after heparinized saline irrigation.

Data analysis

The data were collected using a proforma which was entered into Microsoft excel spreadsheet. The data and medical information were summarized using descriptive statistics as appropriate. Data analysis was done using statistical packages for social sciences (SPSS) version 25.

Ethical Considerations

The study was approved by the research and ethics committee of the University of Port Harcourt Teaching Hospital.

III. Results

A total of 15 patients were recruited for the study during the period under review. All 15 (100%) the cannulae were 16G (gray) and were inserted pre-operatively. Of these, 13 (86.6%) cases were for caesarean section, 1 (6.7%) for abdominal myomectomy and the only male 1 (6.7%) was for a case of intestinal obstruction for laparotomy. Seven (46.67%) of the cannula were inserted by consultants, 4 (26.67%) by senior resident doctor, and 4 (26.67%) by junior resident doctors. All (100%) of the 16G cannulae were made by the same manufacturer. The introducer needle was reinserted in 4 (26.67%) cases, the cannulae were in situ for an average of 3-5days intravenously, most 10 (66.67%) of the patients presented within 24hours, while 5 (33.33%) presented after 24hours. Two of the forearm veins around the wrist were ligated in two patients; while 1 at the proximal forearm, 10 at the cubital fossa and 2 at the neck (external jugular) were repaired. The three fractured cannula that migrated were from the cubital fossa and were all retrieved. They all observed in 5 patients that presented after 24 hours of the incident.

One-third 5 (33.33%) of the patients were aged 25-29 years, while only 1 (6.67%) was in the 40-44 years and 45-49 years group respectively. Most 14 (93.33%) were females. This is shown in Table 1. Table 2 showed the site distribution for the fractured intravenous cannula. The cubital fossa was the most common site 10 (66.67%), while 3 (20%) and 2 (13.33%) were in the forearm and neck respectively. As shown in table 3, 13

(86.67%) patients had a longitudinal venotomy and vein repair with Prolene 7/0, while 2 (13.33%) had longitudinal venotomy and ligation. Eight (53%) of the retrieved fractured segments were identified by finger palpation, four (26.6%) were with the aid of ultrasound scan, while the migrated three (20%) could not be identified. The outcome of interventions is displayed in table 4. Of the 15 patients, 12 (80%) had successful retrieval of fractured distal segment, while 3 (20%) experienced unsuccessful retrieval with migration of fractured segment.

The procedure for the retrieval of fractured peripheral intravenous cannula identified by palpation before retrieval in two patients is displayed in figure 1. The proximal and retrieved distal segments of a fractured peripheral intravenous cannula from two different patients is shown in figure 2.

Table 1: Demographic Characteristics of the patients

Variables	Frequency	Percent (%)
Age Group (years)		
25-29	5	33.33
30-34	4	26.67
35-39	4	26.67
40-44	1	6.67
45-49	1	6.67
Gender		
Male	1	6.67
Female	14	93.33

Table 2: Distribution of site of cannula fracture

Site	Frequency	Percent (%)
Cubital fossa	10	66.67
Forearm	3	20.00
Neck	2	13.33

Table 3: Interventions Carried Out

Intervention	Frequency	Percent (%)
Venotomy and vein repair with Prolene 7/0	13	86.67
Venotomy and ligation	2	13.33

Table 4: Outcome of Interventions

Outcome	Frequency	Percent (%)
Successful Retrieval of fractured distal segment	12	80
Unsuccessful Retrieval with migration of fractured segment	3	20

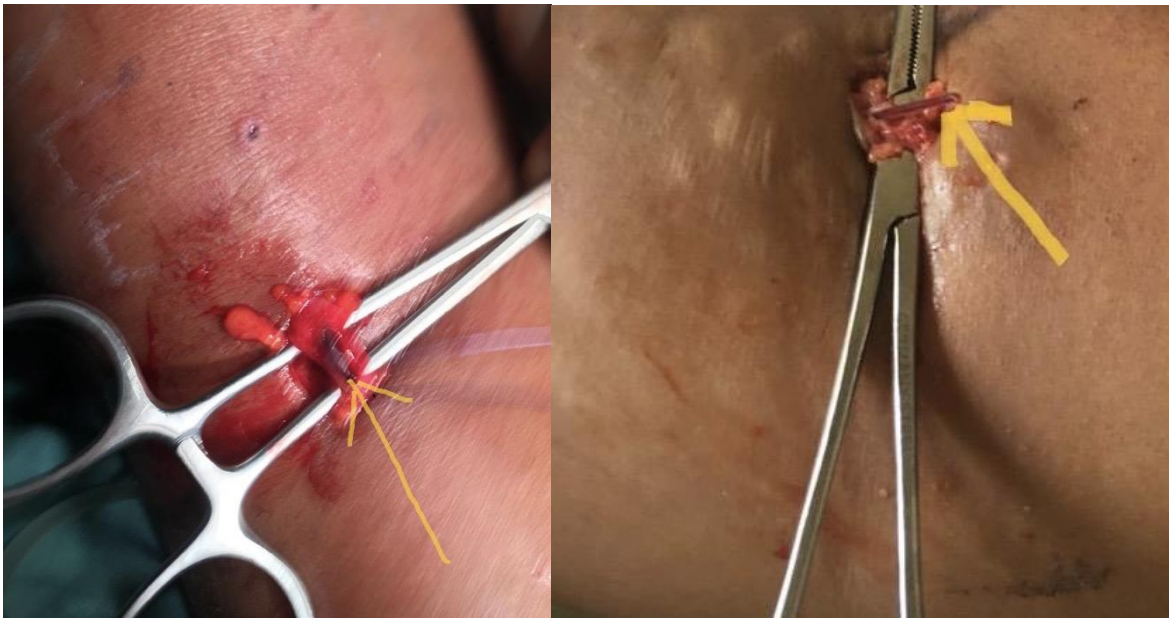

Fig 1: Operative sessions for two different patients with the fractured peripheral intravenous cannula segments sticking out just before retrieval.

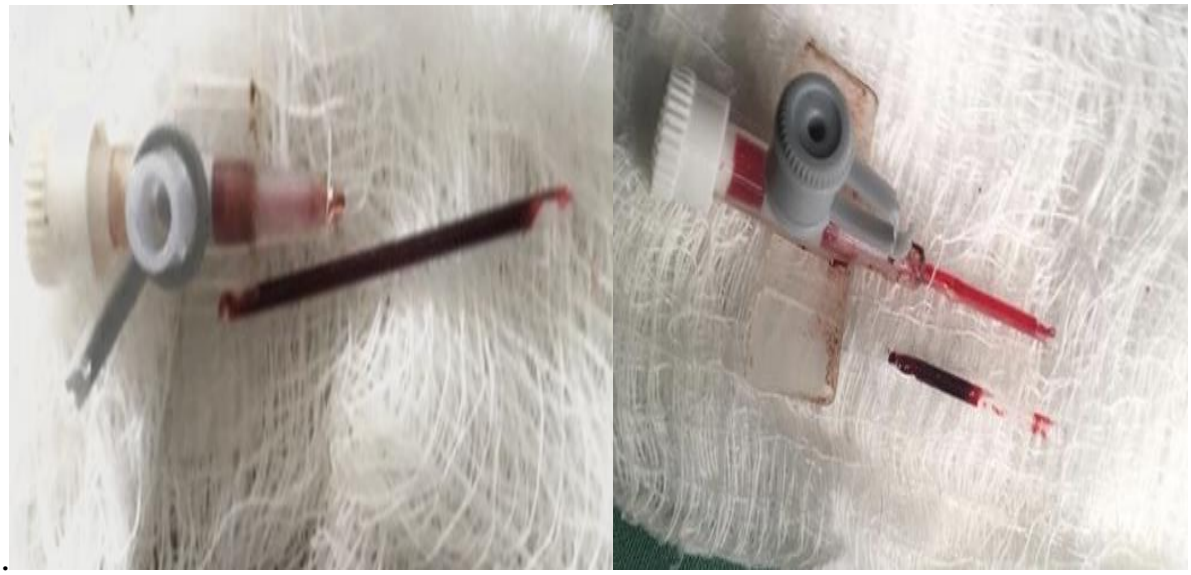

Fig 2: Proximal and retrieved distal segments of a fractured peripheral intravenous cannula from two different patients.

IV. Discussion

Peripheral intravenous cannulation is a common procedure in medical practice, with the possibility of facture and eventual retention of broken parts in veins considered a rarity.[4] A total of 14 females and 1 male had PIC fracture in this study. The predominant age group was 25-29 years (33%) as seen in this study, while the oldest age was 49 years. Similarly, Isiguzo et al[1] also reported a 33% incidence of PIC fracture among the 25-29 years age group old at a tertiary hospital in Southeast Nigeria. However, cases of PIC fracture had been reported to occur at all age groups. Furthermore, PIC fracture had been reported in patients as young as 30-month-old, and as old as 76 years.[3,5,6,13]

PIC fracture can occur at any insertion site within the body; however, the major site in this study was the Cubital fossa with 66% of reported fractures occurring at this site. This is the highest documented incidence among several case series previously reported. Similar findings were observed by Isiguzo et al[1], Ezeah et al[5], Kumar et al[11], Masood et al [4], and Singh et al[12], who all reported fractures at the cubital fossa.

The least occurring site for the fracture in our study was the neck, as this was only observed in two of the cases. The main reason for this might be because the arms offer a more comfortable position for cannula insertion, and the neck is only used in special situations. Moreover, thirteen of our cases were women who were to undergo caesarean section, thus the most common site for cannula insertion in these cases were the arms. However, the jugular vein seems to be the most widely used area in the neck for cannula insertion. Reports from Gunawardena and Gunawansa[13], Mishra et al[15], and Syeda et al[16] had all shown the occurrence of PIC fracture at the jugular veins of the neck.

Inexperienced insertion technique, several failed attempts at cannulation and structural defect of the cannula have been reported to cause PIC fractures. [14] Similarly, intravenous cannulations carried out under emergencies are at higher risk of resulting in complications.[11] Another factor that may cause cannula fracture is the continuous attempt to remove the device by the patient.[5] However, in this study all the 16G cannula that were fractured were from the same manufacturer, which further raised suspicion about the integrity of the cannula. The incidence of cannula fracture drastically reduced when another brand of cannula was used. Hence, it was evident that cannula integrity was also a risk factor for PIC fracture.

Currently, there is no standardized protocol for retrieving intravenous fractured cannula.[3,4] Although the first principle is to quickly locate the fractured cannula by clinical examination to forestall embolization at the proximal site.[5] Failure of clinicians to detect the fractured segments is an indication for radiologic techniques. In this study, eight of the cases were identified by finger palpation, four were diagnosed using radiologic technique, specifically ultrasound, while three cases could not be identified due to migration of the fractured segments. In all twelve cases where the fractured segments were detected, venotomy under local anaesthesia was conducted with the successful removal of these fractured segments. Although all the cases were fractured segments of 16G cannuale, this technique agrees with other authors who had successfully used venotomy to retrieve 23G and 17G.[13,17] In other literatures, other types of surgical techniques such as Z-Plasty Incision,[5] novel J-Flap technique[1], surgical incision and phlebotomy,[15] have all been described for retrieval of fractured cannula segments.

The outcome of retrieval was quite good, as all fractured segments diagnosed by palpation and ultrasound were successfully retrieved, giving an 80% success rate. As observed in this study, early presentation and detection contributed to the successful retrieval of fractured cannula. This agrees with the findings of Freiberg et al,[8] Gunawardena and Gunawansa[13] that delayed detection of fractured cannula fragments increases the risk of migration, complications and even death. Despite the 80% success rate, none of the patient had severe complications associated with intravenous cannula fracture. Furthermore, this outcome is like the study by Isiguzo et al[1] who reported a 100% successful retrieval rate and no complications in his case series.

V. Conclusion

Though, technical error during insertion could be a contributing factor, the quality of the cannula in this study appeared to have contributed more to the increased rate of cannula fracture as the rate reduced drastically when the brand of peripheral intravenous cannula was discontinued. However, timely detection, reporting and intervention were key to successful retrieval as the few that migrated were observed among those that presented late.

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Conflicts of Interest
The authors have no conflicts of interest to declare.

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